LINEAR DEMOLITION CHARGE (LDC) TESTING

BY

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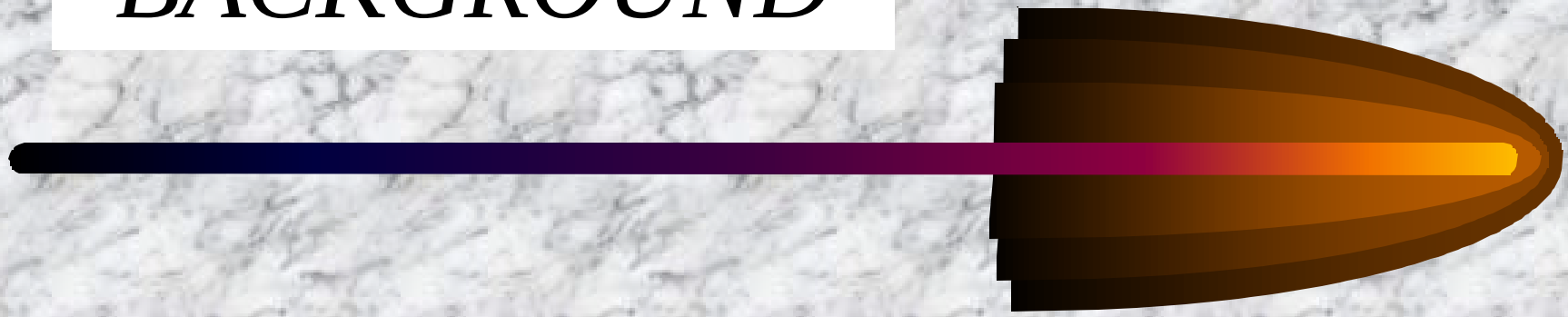
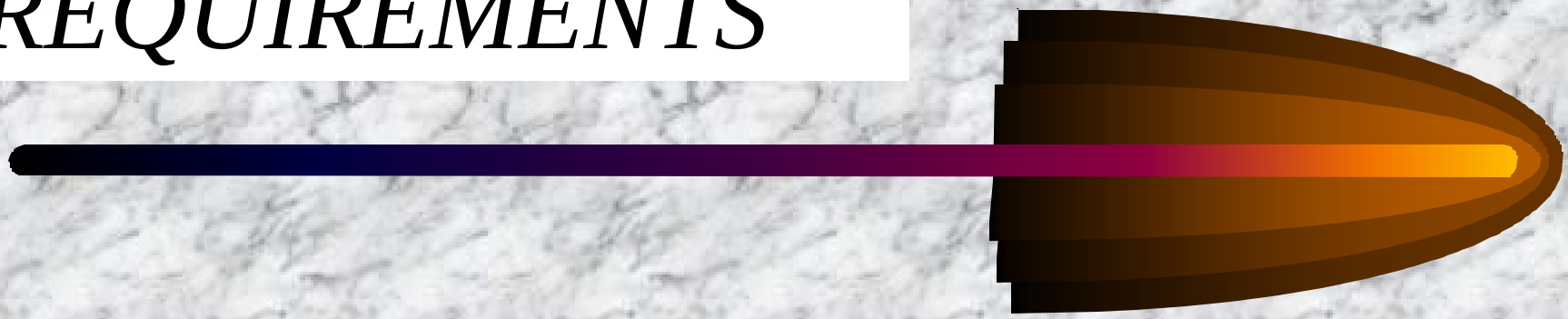
BACKGROUND



- PRODUCT IMPROVEMENT PROGRAM
  - CHARGE DEPLOYMENT
  - FUZE ARMING
  - FUZE FIRING
  - CHARGE DETONATION
- RELIABILITY
- SAFETY

TEST CONDUCT REQUIREMENTS

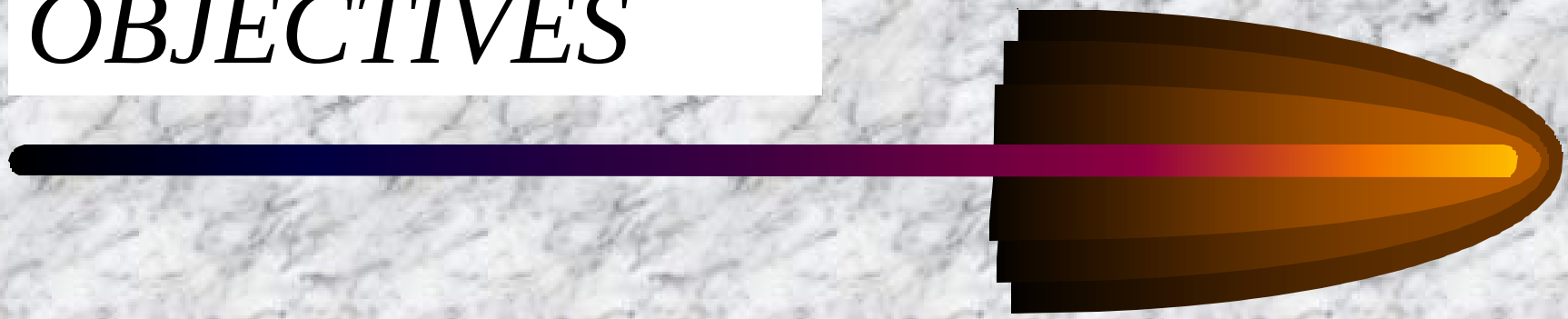


- IDENTIFY TEST CONCEPTS
  - TO EVALUATE PERFORMANCE
  - TO COLLECT DATA
  - TO DETERMINE INSTRUMENTATION REQUIREMENTS
  - SURVEY SUITABLE TEST RANGE

TEST CONCEPT

- TEST 3 INERT LINE CHARGES
- FILM CHARGE EGRESS FROM TUB
- TEST WITH HE LINE CHARGES
- RECORD FUZE ARMING CIRCUIT
- COMMAND DETONATE LINE CHARGE
- EOD ASSIST IN MISFIRES AND DUDS

TEST OBJECTIVES



- DOES THE LINE CHARGE DEPLOY AS DESIGNED?
- DOES THE LINE CHARGE FUNCTION AS DESIGNED?
- WHAT IS THE ARMING TIME OF THE FUZE?
- DOES THE FUZE DETONATE THE LINE CHARGE?

TEST CRITERIAS

- THE ROCKET MOTOR MUST PULL THE CHARGE FROM THE CONTAINER WITHOUT BREAKING OR KNOTTING THE CHARGE
- THE FUZE MUST ARM
- THE FUZE MUST DETONATE ON COMMAND
- THE FUZE MUST DETONATE THE LINE CHARGE

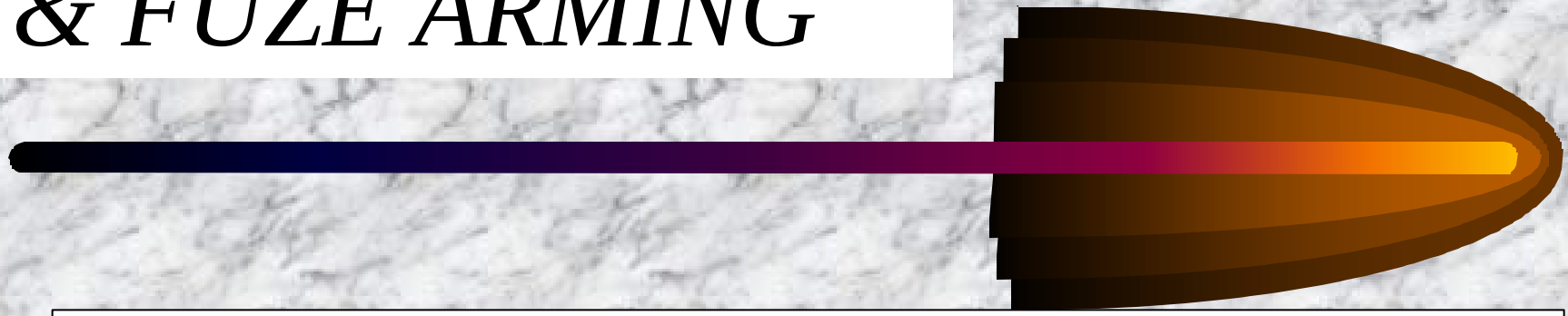
SUMMARY

- TEST CONCEPTS
- TEST OBJECTIVES
- TEST CRITERIAS

Mk 155 LMC

Mk 154 LMC

ROCKET IGNITION & FUZE ARMING



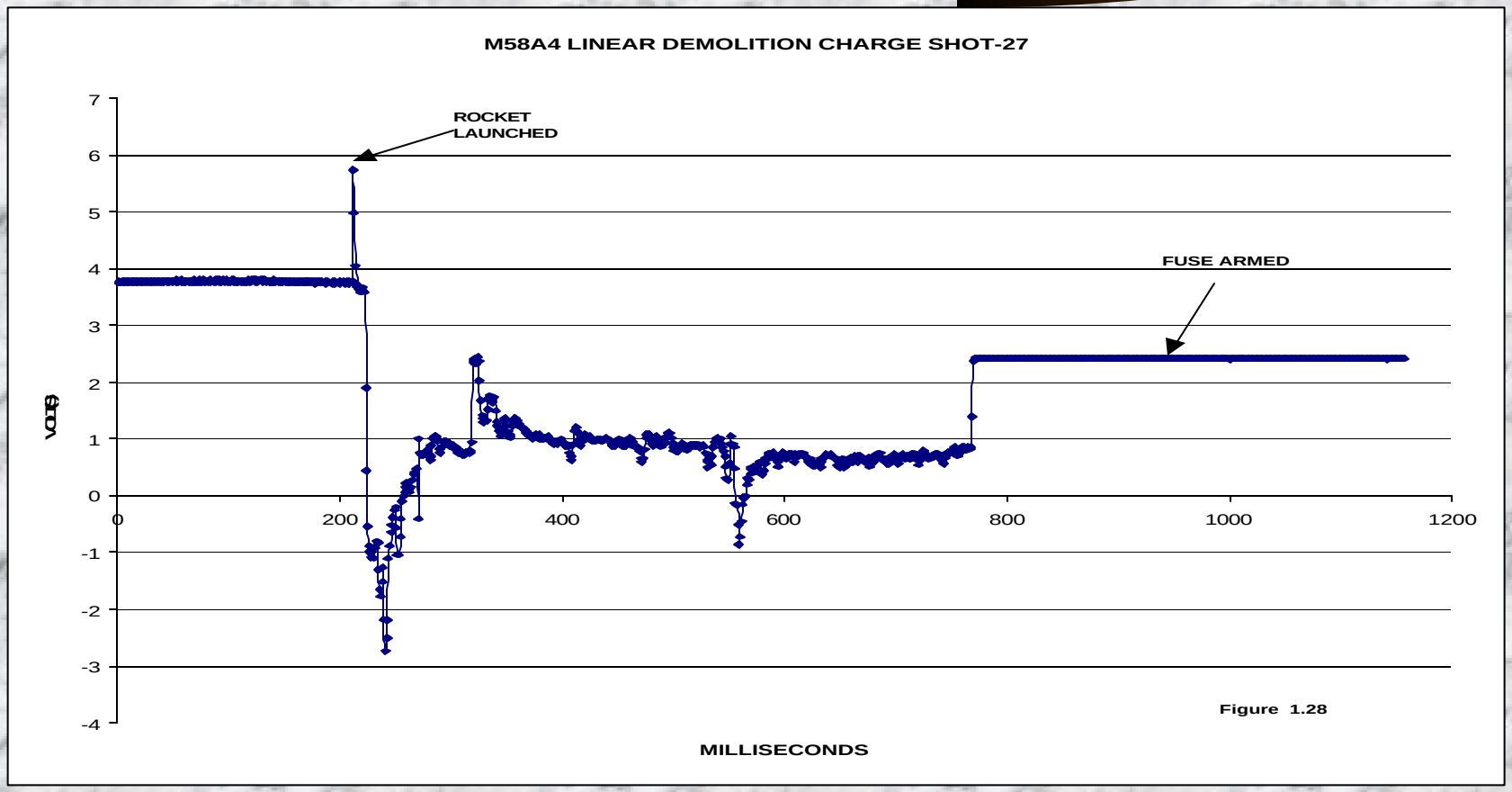


Figure 1.28

SUMMARY

- TEST CONCEPTS
- TEST OBJECTIVES
- TEST CRITERIAS

LINEAR DEMOLITION CHARGE (LDC) TESTING

By Robert Culanag and Van Thai
Amphibious Vehicle Test Engineers

This paper identifies and documents the test concepts, objectives, and test criterias for a line charge product improvement program. A product improvement program at the Naval Surface Warfare Center Ordnance Engineering Directorate, Crane Division at Crane, Indiana has performed engineering changes on existing lots of stockpiled line charges with the goal of improving the reliability and safety in the combat tactical environment. The Crane Division has tasked the Amphibious Vehicle Test Branch (AVTB) at Camp Pendleton, California to assist in providing civilian resources and Marine Corps personnel to conduct the test and evaluation.

The use of the line charge to clear a lane through a minefield during amphibious assaults has been employed in the Marine Corps tactics since the 1960's. The inventory of line charges during the following years has not depleted the stockpile of these line charges and new purchases for improved line charges would not be economically advantageous as budgets become less. New purchase cost is over $40,000 for a single line charge which is four times the original cost of $10,800.

Over the years, engineering improvements have been designed to improve the reliability and safety of these linear charges. Past history of using these existing charges revealed uncommanded airbursts, fuze not arming and a nonlinear deployment of the explosive C4 charge. The constant design improvements in reliability and increased safety for our Marines is foremost. The latest improvements shall test for charge deployment, fuze arming, fuze firing, and detonation of the line charge.

The physical events involve use of a rocket propulsion system, a fire control system, and a payload and delivery system. The rocket propulsion system is a solid fuel rocket in which the payload is external to the rocket. The two types of delivery systems is either a AAVP7A1 amphibious vehicle with the mine clearance system mounted on the vehicle which is designated the Mark 1 Mod 0 mine clearance system. This system has the capability to house and fire three linear demolition charges from water or land. The second delivery configuration is a trailer chassis in which the mine clearance system is mounted on a trailer chassis and towed by an AAVP7A1 vehicle. This is designated the Mark 2 Mod 0 mine clearance system and was developed because of the tactical need to employ the LDC with a ground mounted system during the late 1960's and into the 1970's. This provided greater ease in moving and employing the LDC and could be towed behind a tracked vehicle. The Mk 2 Mod 0 ground mounted system solved the mobility requirement for ground operations and the Mk 1 Mod 0 provides the amphibious breaching capability requirement.

The Mk 2 Mod 0 mine clearance system is the test configuration for the linear demolition charge test. The system components of the single shot Mk 2 Mod 0 mine clearance system consists of the Mk 155 Launcher Mine Clearance (LMC), a M58A4 Linear Demolition Charge (LDC), M1134A3E1 fuze, and one Mk 22 Mod 4 rocket motor. Preoperational test set up required Marines from the Combat Engineering Battalion to secure the Mk 2 Mod 0 system by immobilizing the trailer forward of the

tracked vehicle with engineer stakes. Follow on tests required the trailer to be attached to the tracked vehicle pintle hook.

During testing and data acquisition, the amphibious vehicle serves as a protective shelter from the forward blast and as a data collection vehicle. The majority of the Mk 2 Mod 0 kits are in the Combat Engineering Battalions and their support provides the opportunity for realistic unit training and proficiency. Testing provides the added fallout benefit for unit training as testing becomes a continuous effort at AVTB.

The sequence of events that follows as the Marine is given the clear signal to initiate the mine clearance system is to provide the ignition voltage for the rocket motor from the blasting machine. The launch rail is at its intended 45 degree angle and ignition voltage is transmitted to the rocket motor. The thrust and propulsion from this rocket tows the linear demolition charge from its tub container and over the "active" mine field. The rocket motor burns out at approximately 6 seconds in which the height of its maximum trajectory is reached and continues to travel to the end of its trajectory fully deploying the demolition line charge in a linear fashion. Prior to the end of the rocket trajectory, an arresting cable at the trailer end in which a fuze is situated between the arresting cable and the line charge stops the continuing momentum. At this instant the fuze shear pin is broken arming the fuze and making electrical continuity to the C4 charges. A 5 second delay count down and a second ignition voltage is applied to the fuze to detonate the line charges in the breaching lane. The overpressure from the LDC will clear a lane 50 feet (16m) wide and 350 feet (100m) in length against single impulse, non-blast resistant, pressure fused mines.

The **Test Concept** based on a given sequence of events is summarized in the following paragraph. The test sequence is conducted on 3 M68A2 inert line charges before proceeding to M58A4 high explosive (HE) line charges. The launch of the rocket and line charge are filmed with a high speed camera to facilitate analysis of the spiral egress characteristics of the LDC as it leaves the tub container. The camera frame rate is greater than 400 frames per second allowing a slow motion playback of the C4 blocks being pulled cleanly from the packing. If a premature detonation signal is detected when launching an inert line charge, then testing shall not proceed to firing the M58A4HE line charge. A premature detonation voltage may result from electrostatic charges accumulating from the atmosphere due to low humidity and the nylon encased C4 charges.

The fuze circuit ,the blasting machine circuit and the rocket firing signals are monitored and recorded by a Advanced Onboard Computing System(ADOCS). The collected data is analyzed and displayed to show the initial impulse firing voltage for the rocket, fuze arming circuit complete, and detonation signal voltage for the charge. The data is also displayed to assure that data that is being recorded is valid data.

Malfunctions are investigated to determine cause of the malfunction and may require Explosive Ordinance Disposal (EOD) assistance. Misfires and duds are handled by EOD if immediate action fails to correct the problem.

The **Test Objective Issues** are:

1. Does the line charge deploy as designed?
2. Does the line charge function as designed?
3. What is the arming time of the fuze?
4. What is the time between the arming of the fuze and firing of the fuze?
5. Does the fuze detonate the M58 line charge?

The **Test Criterias** are:

1. The rocket motor must pull the charge from the container without breaking or knotting the charge.
2. The fuze must arm.
3. The fuze must detonate on command.
4. The fuze detonation must detonate the line charge.

These Test Criterias are traceable upwards to the Test Objectives. If the test criterias are not satisfied then the single line charge test event has failed. The number of failed test events and successful test events with their associated data are recorded and reported in a final test report to the customer.

The final report generated is submitted to the customer with conclusions and recommendations. Future testing shall be determined by the customer when new improvements or vendor item changes would affect the performance of the existing demolition charge.

AVTB's capability to test amphibious vehicles with the line charge test is another example of the challenge that adds to the diversity of AVTB's capability. Marines and civilians comprise the team that support our test efforts. The following video demonstrates the line charge test in action and our test efforts to produce a quality product.